Depressive Symptom Severity as a Predictor of Attendance in the HOME Behavioral Weight Loss Trial

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Introduction

Obesity is a major public health problem due to its high prevalence and serious ramifications (1, 2). Approximately 38% of adults in the U.S. have obesity (1), and non-Hispanic Black women are disproportionally affected, with a prevalence rate of 58% (3). Lifestyle change – primarily in diet and physical activity – is the first-line treatment for obesity (4). The U.S. Preventive Services Task Force recommends that clinicians offer or refer adults with obesity to "intensive, multicomponent behavioral interventions" (5). Unfortunately, people who are economically disadvantaged have limited access to behavioral weight loss programs designed to promote lifestyle change (6). In addition, such programs are notorious for poor attendance. For example, Lemstra and colleagues (7) found that, across behavioral weight loss trials, the average attendance is 63%. This is problematic, as better program attendance has been associated with improved weight loss and maintenance outcomes (8-10). Moreover, it has been found that retention in behavioral weight loss trials is low (11), and the amount of weight loss is lower for non-Hispanic Black versus non-Hispanic White women (12). Collectively, these observations have motivated a search for predictors of poor behavioral weight loss attendance, as such factors could be addressed preemptively or concurrently to improve program attendance and weight-related outcomes.

Depression is a candidate predictor of poor behavioral weight loss attendance for several reasons. First, the prevalence of depression is elevated in people with obesity (13). Second, depression has been associated with poorer adherence to provider recommendations to manage weight and to increase physical activity in U.S. adults (14) and to medical recommendations in general among patients with chronic diseases (15, 16). Third, in their systematic review, Moroshko and colleagues (17) observed that five of 10 studies detected an association between

greater depressive symptoms and higher dropout in weight loss interventions, an outcome conceptually related to poor attendance; other studies have supported these findings (18-20).

To our knowledge, only four prior studies have examined the association between depression and behavioral weight loss attendance. In a sample of women with obesity in primary care, Ludman and colleagues (21) did not observe such a relationship. Conversely, in a sample of adults with obesity, Clark and colleagues (22) found higher depressive symptom severity was negatively related to number of sessions attended. Similarly, among adults with obesity in an outpatient multidisciplinary weight management program, McLean and colleagues (23) found people with, versus without, a depression diagnosis attended fewer sessions and had lower completion rates. Trief and colleagues (24) also found that, among adults with obesity in a behavioral weight loss trial with a telephonic delivery method, those with elevated depressive symptoms were less likely to attend more than half of the sessions, less likely to achieve at least 5% weight loss, and had lower mean weight loss.

At present, the extant literature is limited, as no studies have utilized samples selected from racially and economically diverse backgrounds, have investigated depressive symptom clusters (e.g., cognitive/affective and somatic clusters) as predictor variables, or have examined attendance in innovative interventions (e.g., in-home group sessions) that could improve program attendance among people with barriers to attending in-clinic groups (25, 26). Thus, the objective of the present study is to examine total depressive symptom severity and depressive symptom clusters as predictors of behavioral weight loss attendance among adults who are economically disadvantaged, a group that experiences elevated rates of both depression and obesity (27-29). We hypothesized that total depressive symptom severity would be associated with attendance such that participants with higher depressive symptom severity would have elevated odds of

being in the no or poorer attendance groups. We also explored relationships between depressive symptom clusters and attendance, although we did not have specific hypotheses. It is important to examine depressive symptom clusters in this context due to their potential to differentially impair behavioral weight loss initiation and maintenance (for specific examples, see Discussion).

We analyzed data from the recently completed HealthyMe Online Weight Management Education/HealthyMe at Home (HOME) randomized controlled trial (30), in which participants were randomized to one of three arms: in-person weight management, in-home video conference weight management, or enhanced usual care. The HOME trial provided an excellent opportunity to achieve our objective, given that (a) it was conducted in the primary care clinics of a safety net healthcare system serving a high percentage of racial minorities and (b) the video conference weight management arm leveraged technology to deliver sessions in the participants' homes.

Methods

The HOME Trial

The HOME Trial (30) (ClinicalTrials.gov Identifier: NCT02057952) is a 12-month, three-arm randomized controlled trial that was conducted in primary care clinics of Eskenazi Health, one of the largest safety net healthcare systems in the U.S. The trial was approved by the Indiana University-Purdue University Indianapolis Institutional Review Board. The HOME trial sought to provide evidence for home- and community-based behavioral weight loss in an effort to make behavioral weight loss programs more accessible for patients and more feasible for providers.

Potential participants were called to be screened if their electronic medical record indicated they were age 40-64 years; had a body mass index (BMI) of 30-50 kg/m^2; had a residential address within Marion county, Indiana; spoke English; did not have evidence of a

cardiovascular event in the past six months; did not have a diagnosis of congestive heart failure, type 2 diabetes, asthma, bipolar disorder, or psychosis; and had a Federally Qualified Health Center (FQHC) provider referral to the Eskenazi Health's HealthyMe lifestyle management program. Eskenazi Health operates ten FQHCs in the Indianapolis metropolitan area. FQHCs receive funding from the U.S. Health Resources & Services Administration and follow strict federal requirements that include location in an underserved area and providing care regardless of ability to pay. Upon completion of phone screening, potential participants remained eligible if they had access to a phone and a residence, passed a 6-item cognitive screener (31), did not have previous or planned bariatric surgery, did not have a substance use disorder, and were not receiving disability insurance. Written informed consent was obtained from all individual participants included in the study.

During recruitment, 1,598 primary care patients were screened for eligibility, and 150 were randomized to one of three arms: in-person weight management (intervention; $n = 49$), video conference weight management (intervention; $n = 50$), or enhanced usual care (control; $n = 51$). Randomization utilized a random number generator, occurred immediately after the baseline assessments, and was stratified by race (Black, White). Assessors were blinded to group assignment. Both intervention arms received the same services delivered by interventionists who were trained research assistants with a BS or MS degree in nutrition, exercise science, or health promotion. One co-investigator did regular fidelity checks to ensure consistency across interventionists. Participants in the in-person arm attended sessions at local healthcare centers or other public community centers. Participants in the video conference arm were equipped with desktop computers with mounted webcams in their homes in order to participate in the live video conferences. In the first 20 weeks, both intervention arms met twice a week for 20-minute

nutrition lessons/discussions and 30-45 minutes of physical activity. After 20 weeks, the twice-weekly sessions tapered to brief nutritional discussions and exercise sessions. These occurred weekly during weeks 21 to 23, every other week during weeks 24 to 39, and monthly during weeks 40 to 52. In both intervention arms, there were 54 possible sessions across the 12-month period. Of note, the interventions did not specifically address depressive symptoms. In the event of suicidal ideation, researchers followed a standard protocol for referral to mental health services. The primary outcome of the HOME Trial was weight loss at 6 and 12 months.

We did not examine associations between depressive symptoms and attendance among participants in the enhanced usual care arm for three reasons. One, participants in all three arms were referred to the HealthyMe program, which was the only treatment provided in the usual care arm. Two, because the HealthyMe program does not have a firm structure, it is impossible to determine the total number of possible sessions and calculate percent attendance for each participant. Three, HealthyMe participation data is available but is not of research quality. It was collected by various ancillary providers and recorded in an electronic medical record that is no longer in use.

Participants

For the present study, we selected the 94 (95%) of 99 participants from the in-person and video conference arms who had complete item data on the Patient Health Questionnaire-8 (PHQ-8).

Measures

Depressive Symptom Severity. At baseline, depressive symptom severity was assessed by the PHQ-8 (32, 33). On a 0-3 scale (not at all to nearly every day), participants indicated how often they experienced the following symptoms of major depressive disorder in the past two weeks: (1) anhedonia, (2) depressed mood, (3) sleep disturbance, (4) fatigue, (5) appetite

changes, (6) low self-esteem, (7) concentration problems, and (8) psychomotor retardation/agitation. Total scores, computed by summing responses to the eight items, range from 0 to 24, with scores ≥ 10 indicating clinically significant symptoms (32). In addition to the total score, we calculated PHQ-8 cognitive/affective (sum of items 1, 2, 6, 7, and 8) and somatic (sum of items 3, 4, and 5) subscale scores consistent with the measure's two-factor structure (34). We converted the PHQ-8 total, cognitive/affective, and somatic scores to *z* scores prior to analysis to improve interpretation and comparison across total and subscale scores due to their different possible ranges. Thus, we report the odds of being in one attendance group versus another based on 1-standard deviation (*SD*) increase in PHQ-8 score.

Behavioral Weight Loss Session Attendance. We computed the percent of sessions attended (sessions attended/total possible sessions) for each participant. For 86 participants, the total number of possible sessions was 54, the maximum number of sessions given the trial design. For the remaining 8 participants, the total number of possible sessions was 45, as one of the 10 groups in the video conference arm had to be terminated early and the participants had to be withdrawn because of safety concerns after threats were made by one of the participants. Due to the large number of 0% values, we recoded percent of sessions attended into a three-level categorical variable: no attendance (0%, $n = 44$), poorer attendance (0.1-32.9%, $n = 24$), and better attendance (≥ 33.0%, $n = 26$). We selected this categorical strategy as our primary approach, as we suspect that the group who attended zero sessions, despite enrolling in the trial, may be qualitatively different in some way(s) from the group who attended any sessions. To also allow for the examination of degree of attendance, we created two groups of approximately equal size involving those who attended any sessions.

Covariates. Our primary models included the following covariates, which were all assessed at baseline: age, sex, race, waist circumference, and health literacy. Age (years) was computed as the time between each participant's date of birth and their baseline visit, and sex (0 = female, 1 = male) and race (0 = White, 1 = non-White) were assessed by electronic medical record and confirmed by self-report. Race was originally assessed with five categories (Black, White, Asian, American Indian or Alaskan Native, and Native Hawaiian or Pacific Islander), and we collapsed these categories into a dichotomous variable due to the very low proportion of participants in racial groups other than non-Hispanic Black (65%) and non-Hispanic White (33%). Waist circumference (in) was measured at the midpoint between the highest point of the iliac crest and lowest part of the costal margin in the mid-axillary line assessed at the baseline home visit. We included waist circumference as a covariate because of its potential to predict session attendance, as those with a relatively smaller waist circumferences may be more physically apt to attend the sessions (19). Health literacy was measured using the Newest Vital Sign, with higher scores indicting greater health literacy (35). We included health literacy as a covariate because of its potential to be positively associated with session attendance.

In supplemental models, we further adjusted for the following potential mechanisms or confounders, which were also assessed at baseline: Physical Activity Enjoyment Scale (PACES), Outcome Expectations for Exercise Scale (OEE), and Self-Efficacy for Exercise Scale (SEE). PACES is a measure of physical activity enjoyment, and higher scores indicate more enjoyment (36). OEE and SEE assess individual expectancy and efficacy for exercise, with higher scores indicating stronger outcome expectations and greater self-efficacy (37, 38). All of these measures are important to include as covariates, given that it is plausible that (a) depression is negatively

associated with each factor and that (b) each factor is positively associated with session attendance.

Data Analysis

All analyses were conducted with SPSS 24 (39). First, we ran *t* tests and χ^2 tests to assess for intervention arm differences. Next, we constructed our primary models. To examine total depressive symptom severity as a predictor of behavioral weight loss session attendance, we ran two multinomial logistic regression models to test the association between PHQ-8 total *z* score and our three-level session attendance variable (no attendance, poorer attendance, better attendance). These models include age, sex, race, waist circumference, and health literacy as covariates. The reference group in the first model was the better attendance group. In the second model, we changed the reference group to the poorer attendance group to obtain all comparisons. To examine depressive symptom clusters as predictors of behavioral weight loss session attendance, we reran the multinomial logistic regression models after replacing the PHQ-8 total *z* score with the PHQ-8 cognitive/affective or somatic *z* scores. Finally, we constructed three sets of supplemental models. First, we reran our primary models after adding PACES, OEE, and SEE scores as covariates. Second, we reran our primary models stratified by intervention arm to explore whether the depressive symptoms-program attendance relationship was similar or different in magnitude in the two treatment groups. Third, to examine session attendance as a continuous outcome, we reran our primary model using zero-inflated negative binomial modeling, which was appropriate because the continuous distribution for session attendance exhibited overdispersion and a high number of zeros ($n = 44$).

Results

Sample Characteristics

As shown in Table 1, no significant differences between the intervention arms on the study variables were observed. Our sample was middle aged (*M* = 53.2 years), economically disadvantaged (household income *M* = $20,219/year), predominantly female (85%) and non-White (68%; 65% non-Hispanic Black, 1% American Indian/Alaskan Native, 1% Asian American, 1% multiracial), and had elevated waist circumference (*M* = 46.5 inches). The mean PHQ-8 total score (7.3) fell in the mild depression range, and 34% of participants had a total score ≥ 10, which is indicative of clinically significant depressive symptoms (32). Overall, behavioral weight loss session attendance was poor, as the mean percent of total sessions attended was only 18%. Forty-seven percent of participants attended zero sessions, and only 28% attended at least a third of the sessions. The benchmark attendance goal for sustained weight loss is 51%, and the average rate of behavioral weight loss session attendance is 63% (7, 40).

Table 1. Characteristics of Participants by Intervention Arm of the HOME Trial

	In-Person Weight Management Arm (*n* = 48)	**Video Conference Weight Management Arm (*n* = 46)**	**Total (*N* = 94)**
Age, years, *M* (*SD*)	53.4 (8.0)	53.0 (6.2)	53.2 (7.1)
Annual household income, U.S. Dollar, *M* (*SD*)†	22,494 (19,846)	17,538 (7,238)	20,219 (15,487)
Female, *n* (%)	38 (79)	42 (91)	80 (85)
Non-White, *n* (%)	31 (65)	33 (72)	64 (68)
Waist Circumference, inches, *M* (*SD*)	46.7 (6.0)	46.2 (4.2)	46.5 (5.1)
Newest Vital Sign, *M (SD)*	3.2 (2.0)	2.9 (1.6)	3.1 (1.8)
Physical Activity Enjoyment Scale, *M (SD)*	84.8 (22.8)	88.8 (23.1)	86.8 (22.9)
Outcome Expectations for Exercise Scale, *M (SD)*	4.1 (0.6)	4.1 (0.6)	4.1 (0.6)
Self-Efficacy for Exercise Scale, *M (SD)*	5.7 (2.0)	6.0 (2.5)	5.9 (2.3)
PHQ-8 Total Score, *M* (*SD*)	6.9 (5.6)	7.6 (5.4)	7.3 (5.5)
PHQ-8 Cognitive/Affective Score, *M* (*SD*)	3.2 (3.5)	3.5 (3.4)	3.3 (3.4)
PHQ-8 Somatic Score, *M* (*SD*)	3.8 (3.0)	4.1 (2.6)	3.9 (2.8)
Percent of Total Sessions Attended, *Mdn* (*IQR*)	0.0 (0.0, 34.3)	3.7 (0.0, 38.0)	1.9 (0.0, 35.2)

Note.
PHQ-8 = Patient Health Questionnaire-8. IQR = Interquartile range (25^{th} and 75^{th} percentiles). There were no significant differences between intervention arms on any of the above factors. †Annual household income is reported on reduced samples due to missing data (In-Person n = 33, Video Conference n = 28, Total N = 61)

Total, Cognitive/Affective, and Somatic Depressive Symptoms Predicting Behavioral Weight Loss Session Attendance

As can be seen in Figure 1, our primary multinomial logistic regression model using better attendance as the reference group showed a significant association between PHQ-8 total *z* score and the odds of poorer attendance versus better attendance. The odds ratio (*OR*) of 1.94 indicates that every 1-standard deviation (*SD*) increase in the PHQ-8 total score was associated with nearly a doubling of the odds of having poorer attendance versus better attendance. The association between PHQ-8 total *z* score and the odds of no attendance versus better attendance was in the same direction and had a magnitude that is potentially clinically important (*OR* = 1.63) but was not statistically significant (p = .08). Our primary model using poorer attendance as the reference group indicated that there was no association between PHQ-8 total *z* score and the odds of no attendance versus poorer attendance (p = .52). In these models, no covariates were related to any of the attendance outcomes (ps > .09).

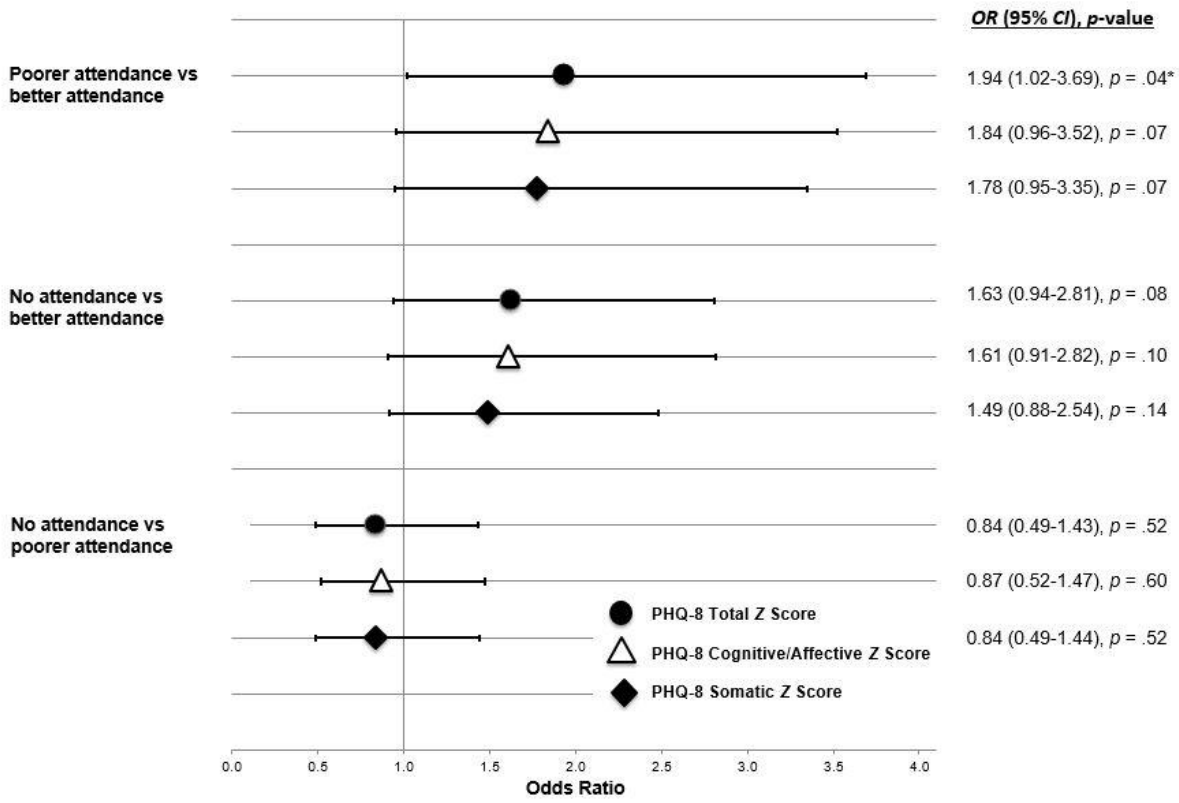

Figure 1. Results of multinomial logistic regression models examining the associations of total depressive symptom severity (PHQ-8 total *z* score) and depressive symptom clusters (PHQ-8 cognitive/affective and somatic *z* scores) with behavioral weight loss session attendance (no attendance, poorer attendance, better attendance). No attendance, poorer attendance, and better attendance groups were defined as percent of total sessions attended equal to 0% (n = 44), 0.1-32.9% (n = 24), and ≥ 33.0% (n = 26), respectively. Models included the 94 selected participants and were adjusted for age, sex, race, waist circumference, and health literacy. PHQ-8 = Patient Health Questionnaire-8. *OR* = odds ratio. *CI* = confidence interval.

*p < .05

Our primary models examining depressive symptom clusters as predictors of attendance revealed that there were no associations between the PHQ-8 cognitive/affective and somatic *z* scores and any of the attendance outcomes (Figure 1). Nonetheless, two observations can be made. First, three of the six tested associations fell just short of statistical significance (*p*s = .07-.10). Second, the associations between PHQ-8 subscale scores and the attendance outcomes were similar in magnitude to each other and to the associations for the PHQ-8 total score.

Our first supplemental models adjusting for other potential confounders or mediators (i.e., PACES, OEE, and SEE) yielded a similar pattern of results. We observed a significant association between PHQ-8 total *z* score and the odds of poorer attendance versus better attendance (*OR* = 2.12, 95% *CI*: 1.02-4.38, *p* = .04), a potentially clinically important association between PHQ-8 total *z* score and the odds of no attendance versus better attendance that was not statistically significant (*OR* = 1.63, 95% *CI*: 0.88-3.05, *p* = .12), and no association between PHQ-8 total *z* score and the odds of no attendance versus poorer attendance (*OR* = 0.77, 95% *CI*: 0.43-1.40, *p* = .39). No covariates were related to any of the attendance outcomes (all *p*s > .07).

Our second supplemental models stratified by intervention arm revealed that both arms contributed to the main effects of depressive symptom severity on attendance. The magnitude of the associations between PHQ-8 total *z* score and the odds of poorer attendance versus better attendance (in-person: *OR* = 2.74, 95% *CI*: 0.86-8.70, *p* = .09; video conference: *OR* = 1.54, 95% *CI*: 0.65-3.68, *p* = .33) and no attendance versus better attendance (in-person: *OR* = 1.48, 95% *CI*: 0.69-3.18, *p* = .32; video conference: *OR* = 1.87, 95% *CI*: 0.79-4.46, *p* = .16) were slightly different across intervention arms, albeit not significantly so (both interaction *p*s > .48).

Our third supplemental model examining attendance as a continuous outcome using zero-inflated negative binomial modeling yielded results consistent with our primary multinomial

logistic regression models. Specifically, the ratio of means was 0.77 (95% *CI*: 0.53-1.11, p = .16), which indicates that the mean number of session attended reduced by 23% for each 1-*SD* increase in PHQ-8 total score. While the association between PHQ-8 total *z* score and number of sessions attended was not statistically significant, the observed effect was in the same direction as that from our primary models, and its magnitude may be clinically important.

Discussion

We report three important findings. Our first finding is that greater depressive symptom severity at the start of a behavioral weight loss program predicted poorer subsequent session attendance in adults who are economically disadvantaged. Our findings add to the smaller literature suggesting an inverse relationship between depressive symptom severity and behavioral weight loss session attendance (22-24) and extend past results to populations disproportionately affected by obesity – namely, adults who identify as racial minorities and/or who are economically disadvantaged. While it is not clear exactly why depressive symptoms predicted behavioral weight loss attendance, we did observe similar associations in our most extensively adjusted models, which included demographic factors, waist circumference, health literacy, physical activity enjoyment, outcome expectations for exercise, and self-efficacy for exercise as covariates. These results suggest that none of these factors operate as mechanisms or confounders of the reported relationships.

Our second important finding is that overall depressive symptoms-program attendance relationships were not driven by a particular depressive symptom cluster, as both the cognitive/affective and somatic clusters contributed about equally. No prior studies of behavioral weight loss program attendance have separately examined depressive symptom clusters. Furthermore, we did not have specific hypotheses regarding which cluster would contribute more

to the overall relationship, although it is important to examine clusters due to their potential to differentially impair behavioral weight loss initiation and maintenance. For example, concentration difficulties (a cognitive symptom) may inhibit executive functioning (41) and might make it difficult for one to understand and implement a complex dietary program. In addition, lack of interest/pleasure (an affective symptom) may impede one's decision making for something that appears initially unrewarding, (42) and thus might inhibit initiation of dietary or exercise programs (43). Moreover, sleep disturbance and fatigue (somatic symptoms) may deter one from sustaining exercise bouts (44). Future depressive symptom cluster research could identify specific intervention targets that are likely to have the greatest beneficial effect on behavioral weight loss program attendance.

Our third important finding is that total depressive symptom severity appears to exert a similar effect across delivery modes of behavioral weight loss programs, including traditional clinic-based interventions and innovative in-home interventions. This finding is consistent with a finding of the parent study: participants with elevated depressive symptoms had a lower likelihood of achieving the 2kg weight loss goal compared to participants without elevated depressive symptoms, and this did not differ significantly across treatment arm (30). To our knowledge, only one prior study has examined depressive symptom severity as a predictor of attendance in an innovative behavioral weight loss intervention designed to remove barriers to participation (24). However, that study did not assess this relationship in a sample of racially diverse or economically disadvantaged adults. Our result suggests that new delivery modes might not be sufficient to address the deleterious influence of depression on behavioral weight loss attendance, perhaps because depressive symptoms may interfere with behavioral weight loss initiation and maintenance similarly, regardless of where the intervention is delivered.

The present findings align well with the growing depression-to-obesity literature and with recent critiques of the one-size-fits-all model of obesity. A meta-analysis of prospective studies has revealed that depression is associated with a 58% increased odds of future onset of obesity (45). In addition to being an emerging risk factor for obesity, our findings and those of similar studies suggest that depression may also impede the behavioral treatment of obesity once onset occurs. The depression-to-obesity literature has potential implications for the treatment of obesity. Field and colleagues (46) posit that grouping people with all types of overweight and obesity together in the same treatment program may prove unsuccessful because of between-person variability in the individual risk factors for and subtypes of obesity. Given that the development of obesity is thought to be the result of an interaction in genes, environment, and lifestyle, practitioners may want to personalize weight loss interventions accordingly (47). Our findings suggest that depression is one such factor that practitioners should consider, as the presence of depressive symptoms may hinder one's pursuit of weight loss.

A key strength of our study is sampling from an understudied population that experiences disproportionately high depression and obesity rates (27, 28). Additional strengths include the separate examination of depressive symptom clusters and examination of attendance in an innovative intervention (i.e., in-home video conference sessions) designed to remove barriers to participation. The present study also has notable limitations. First, the mean percent attendance was low (18%), primarily due to many zeros. We do not know why a considerable proportion of the sample did not attend any sessions, which was a finding we did not anticipate. Perhaps the poor attendance was due to the firm structure and frequent communication in the trial. Intervention sessions had fixed schedules (which may not have been feasible for many participants), and frequent communication may have elevated participants' sense of failure

(which may have led to subsequent nonattendance). As described in a recent American Medical Association report (48), some participants may find more detriment than benefit from feedback, which may lead to avoidance. For most of the trial, group exercise classes occurred twice per week and were accompanied by regular reminders and check-in phone calls, which may have given participants a sense of failure. Additionally, the group exercise format may incur the further ramifications of "public failure." Thus, future trials may benefit from less frequent visits or reminders, less direct feedback about attendance, and more flexible scheduling. Nonetheless, there was good variability in the attendance outcome (*SD* = 25%, range: 0-89%), allowing us to test our hypotheses in a rigorous way. Second, it appears that we were underpowered to detect some potentially clinically important relationships – e.g., the association between depressive symptoms and the odds of no attendance versus better attendance – likely due to our moderate sample size and the restricted range of the outcome variable. Third, although there was a relatively large number of minority participants, the majority came from a single racial group, thus the present findings cannot be generalized to all minorities.

In conclusion, our findings raise the possibility that depressive symptom severity contributes to poor behavioral weight loss session attendance, which may have implications for research and clinical practice. Future research endeavors may consider delivering depression care preemptively or concurrent with a behavioral weight loss intervention in an effort to remove psychosocial obstacles to program attendance and weight loss. Moreover, practitioners may benefit from an awareness of depression's potential role in behavioral weight loss treatment adherence. Increased attention toward depressive symptoms may aid in the public health effort to treat obesity and prevent its serious health ramifications.

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Competing interest

The authors have no competing interest to report.

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Conflict of Interest

The authors have no competing interest to report.

Highlights

- Higher baseline depressive symptom severity associated with poorer attendance
- Cognitive-affective and somatic clusters both contributed to these associations
- Greater baseline depressive symptoms may inhibit behavioral weight loss outcomes